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(54) **TOY SYSTEM, CASING, SEPARATE TOY, SEPARATE TOY ASSESSMENT METHOD, AND PROGRAM**

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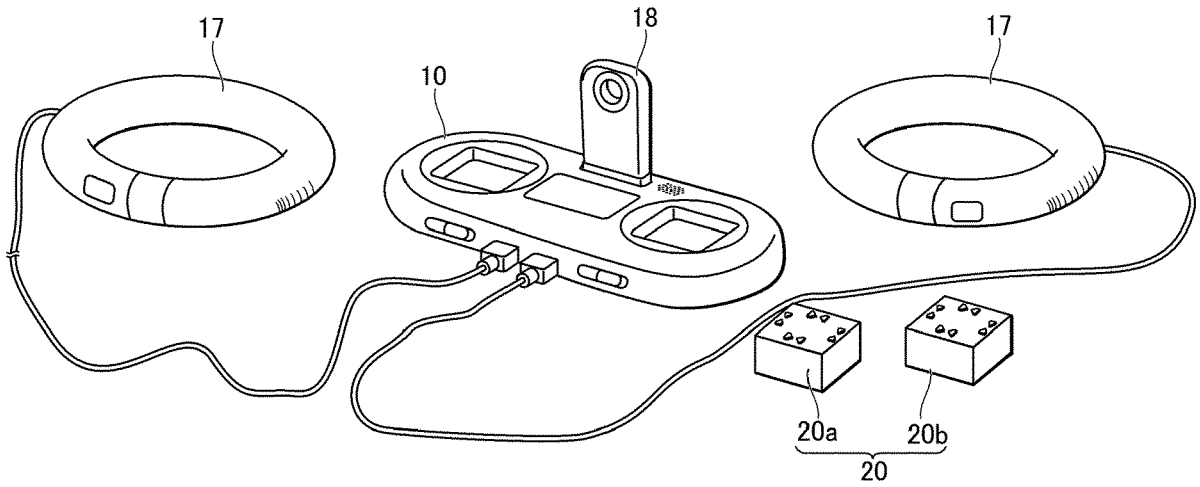
CPC ***A63H 33/26*** (2013.01); ***A63H 30/04*** (2013.01); ***A63H 17/395*** (2013.01)

(57) **ABSTRACT**

To achieve low cost and to provide high durability in a toy system capable of determining a status of a separate toy. The toy system includes a casing, a magnetic sensor, and a determination section. The magnetic sensor is disposed on the casing to detect an orientation and a magnitude of a magnetic field. The determination section determines, based on an output from the magnetic sensor, that one of a plurality of separate toys having magnetic field generation means has approached the magnetic sensor and determines which of the separate toys has approached the magnetic sensor. The magnetic field generation means are mounted individually on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture. Alternatively, the determination section determines, based on the output from the magnetic sensor, that a separate toy separated from the casing in which magnetic field generation means for generating a magnetic field is mounted has come into contact with or approached the casing.



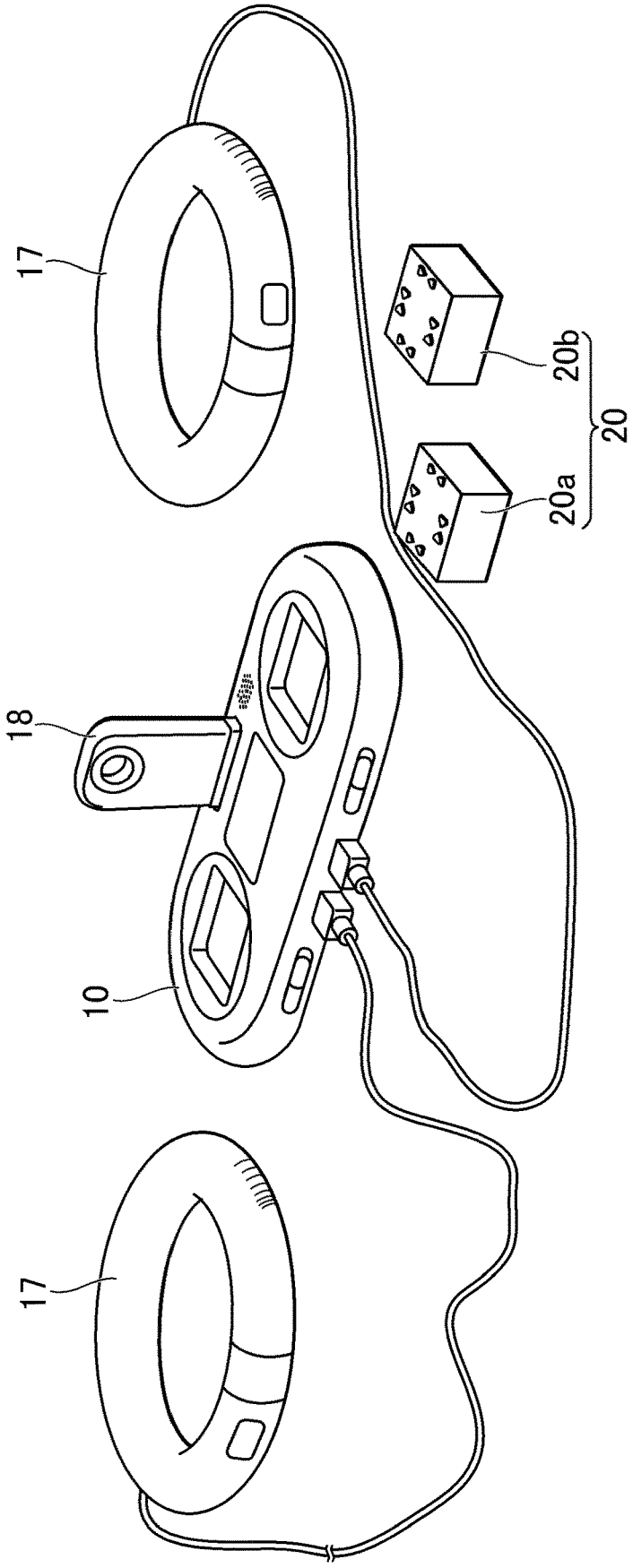


FIG. 1

FIG. 2

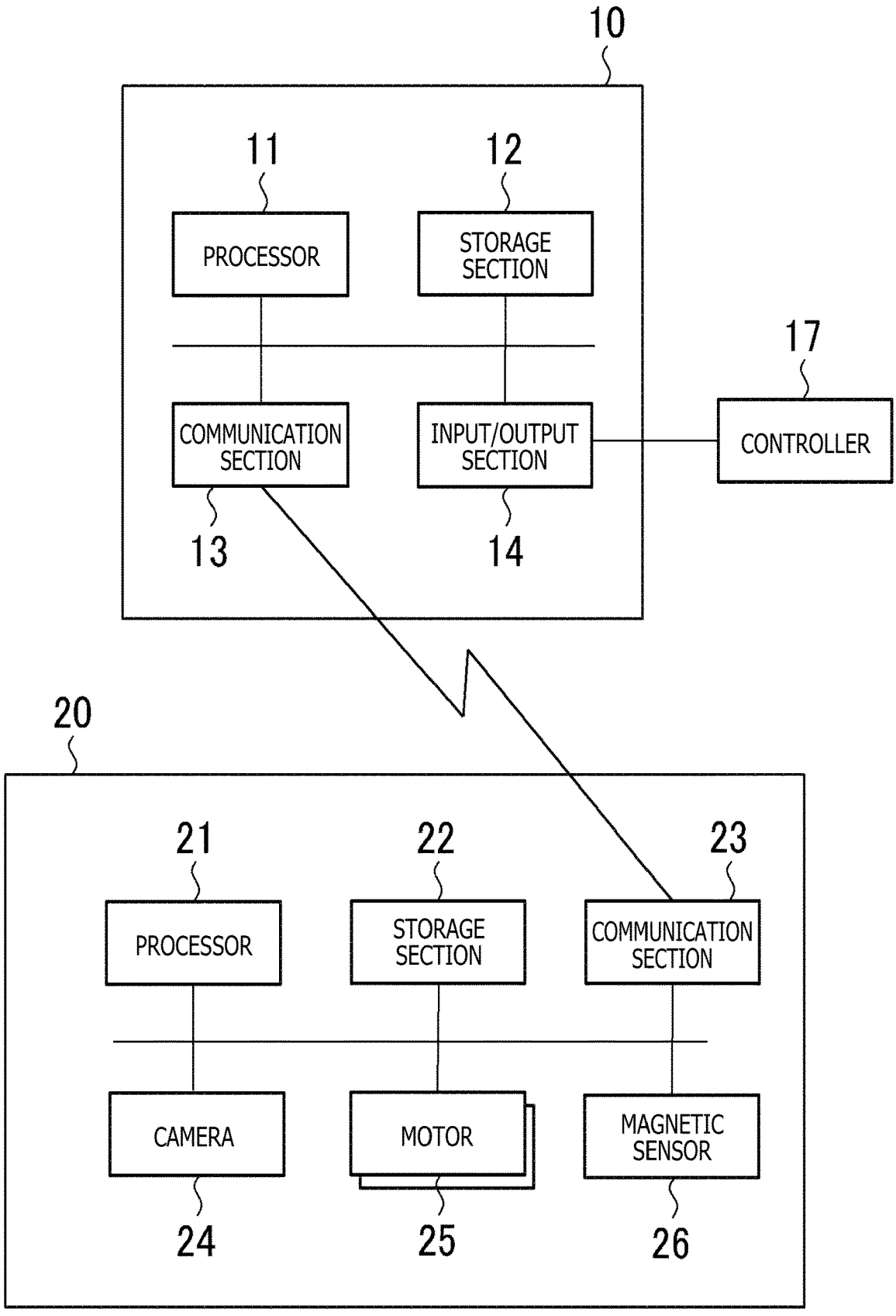

10
11
12
PROCESSOR
STORAGE SECTION
17
COMMUNICATION SECTION
INPUT/OUTPUT SECTION
CONTROLLER
13
14
20
21
22
23
PROCESSOR
STORAGE SECTION
COMMUNICATION SECTION
CAMERA
MOTOR
MAGNETIC SENSOR
24
25
26

FIG. 3

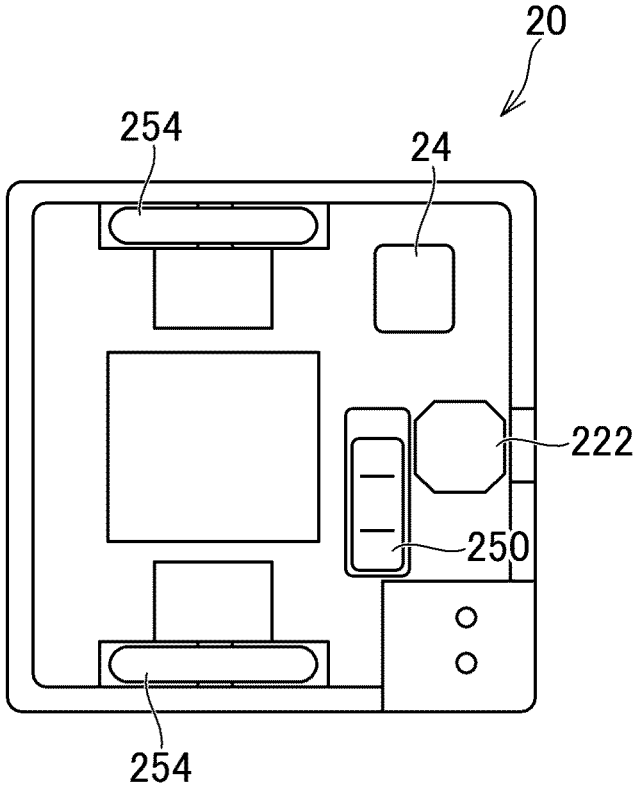


FIG. 4

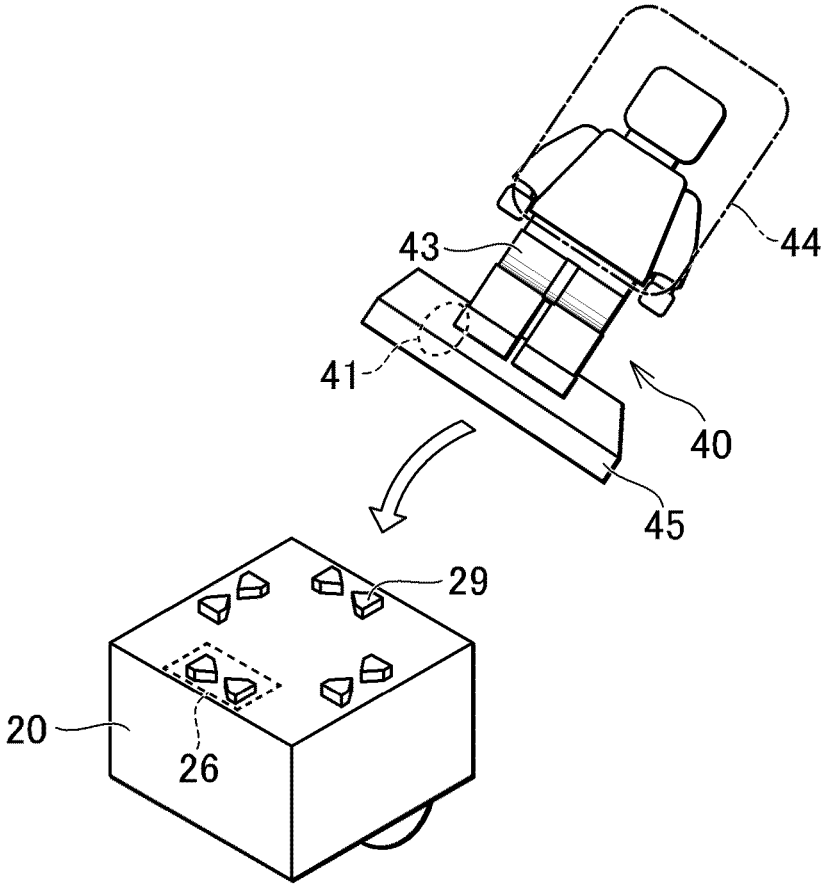


FIG. 5A

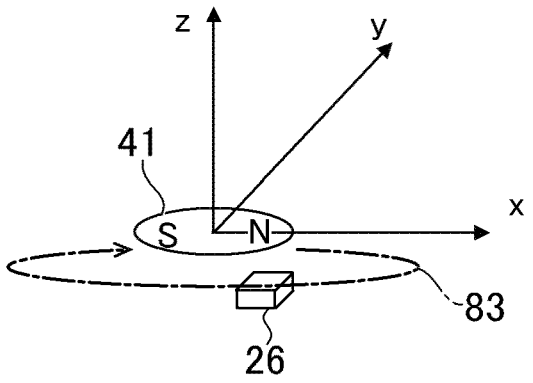


FIG. 5B

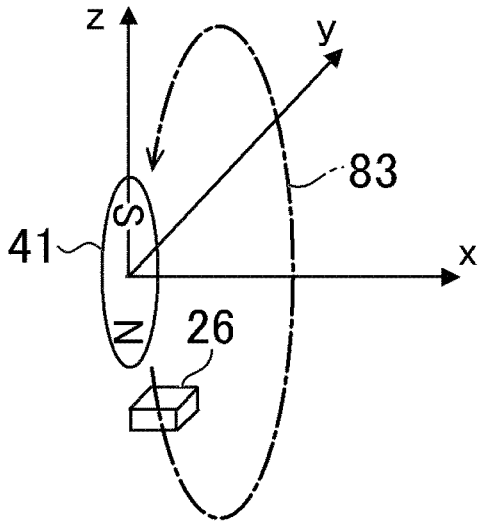

z
y
83
41
S
x
N
26

FIG. 6

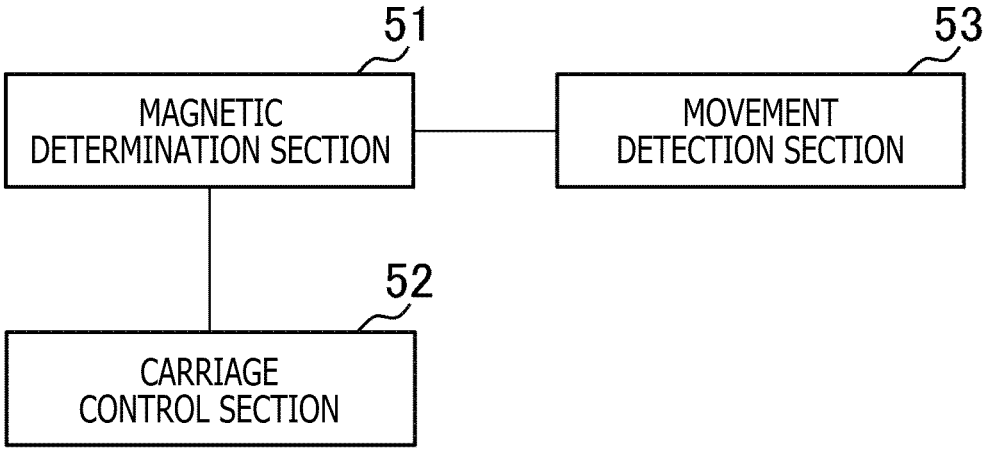

51
MAGNETIC DETERMINATION SECTION
53
MOVEMENT DETECTION SECTION
52
CARRIAGE CONTROL SECTION

FIG. 7

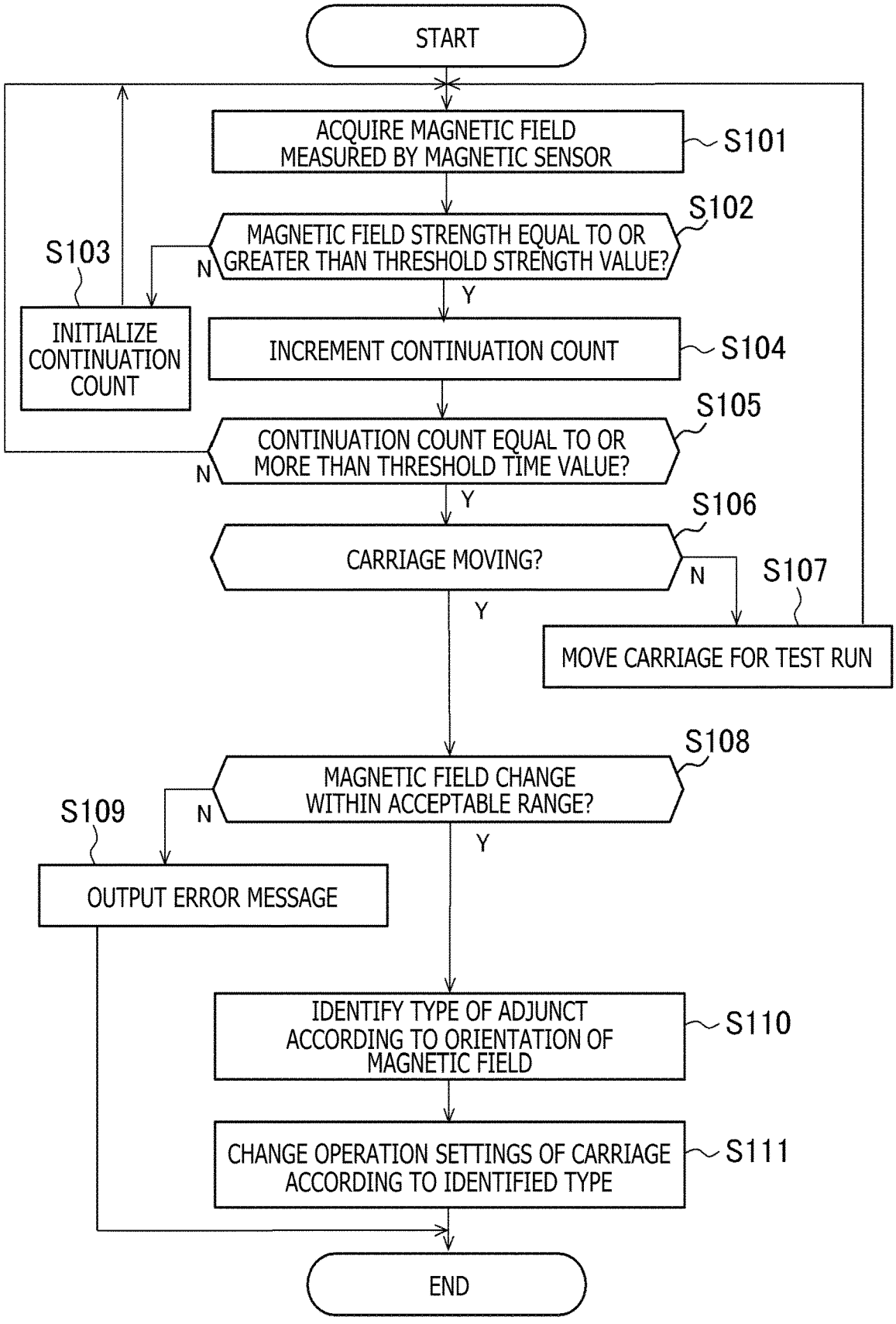

START
ACQUIRE MAGNETIC FIELD MEASURED BY MAGNETIC SENSOR
S101
MAGNETIC FIELD STRENGTH EQUAL TO OR GREATER THAN THRESHOLD STRENGTH VALUE?
S102
N
Y
S103
INITIALIZE CONTINUATION COUNT
INCREMENT CONTINUATION COUNT
S104
CONTINUATION COUNT EQUAL TO OR MORE THAN THRESHOLD TIME VALUE?
S105
N
Y
CARRIAGE MOVING?
S106
N
S107
Y
MOVE CARRIAGE FOR TEST RUN
MAGNETIC FIELD CHANGE WITHIN ACCEPTABLE RANGE?
S108
N
S109
Y
OUTPUT ERROR MESSAGE
IDENTIFY TYPE OF ADJUNCT ACCORDING TO ORIENTATION OF MAGNETIC FIELD
S110
CHANGE OPERATION SETTINGS OF CARRIAGE ACCORDING TO IDENTIFIED TYPE
S111
END

FIG. 8

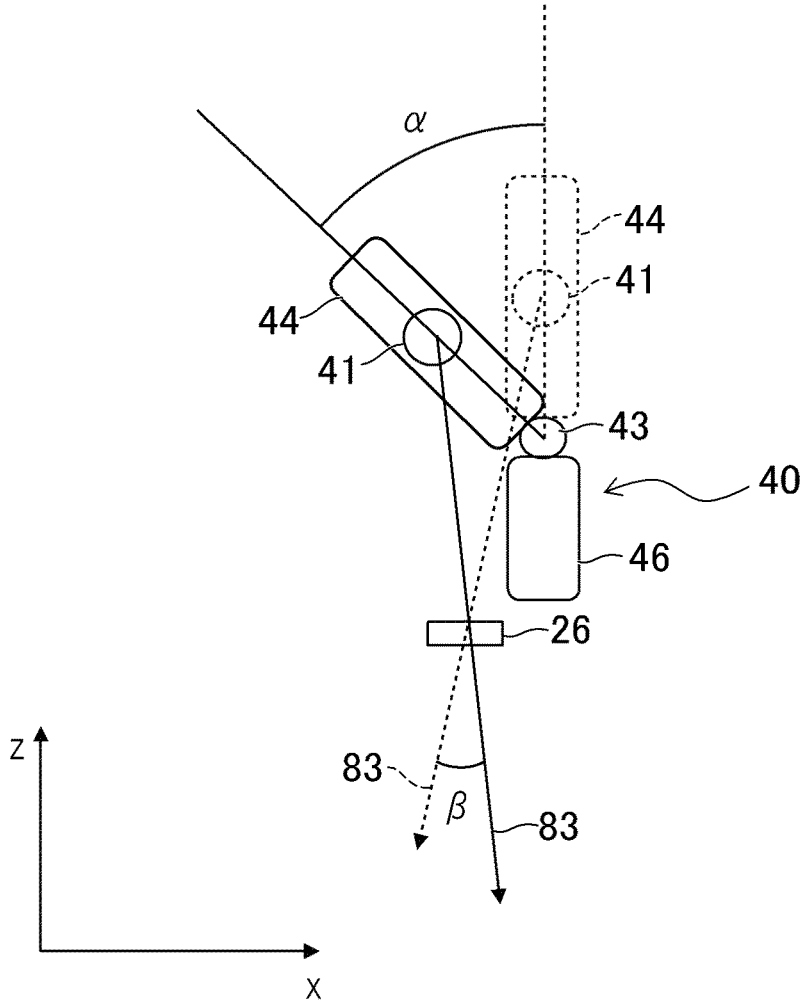


FIG. 9

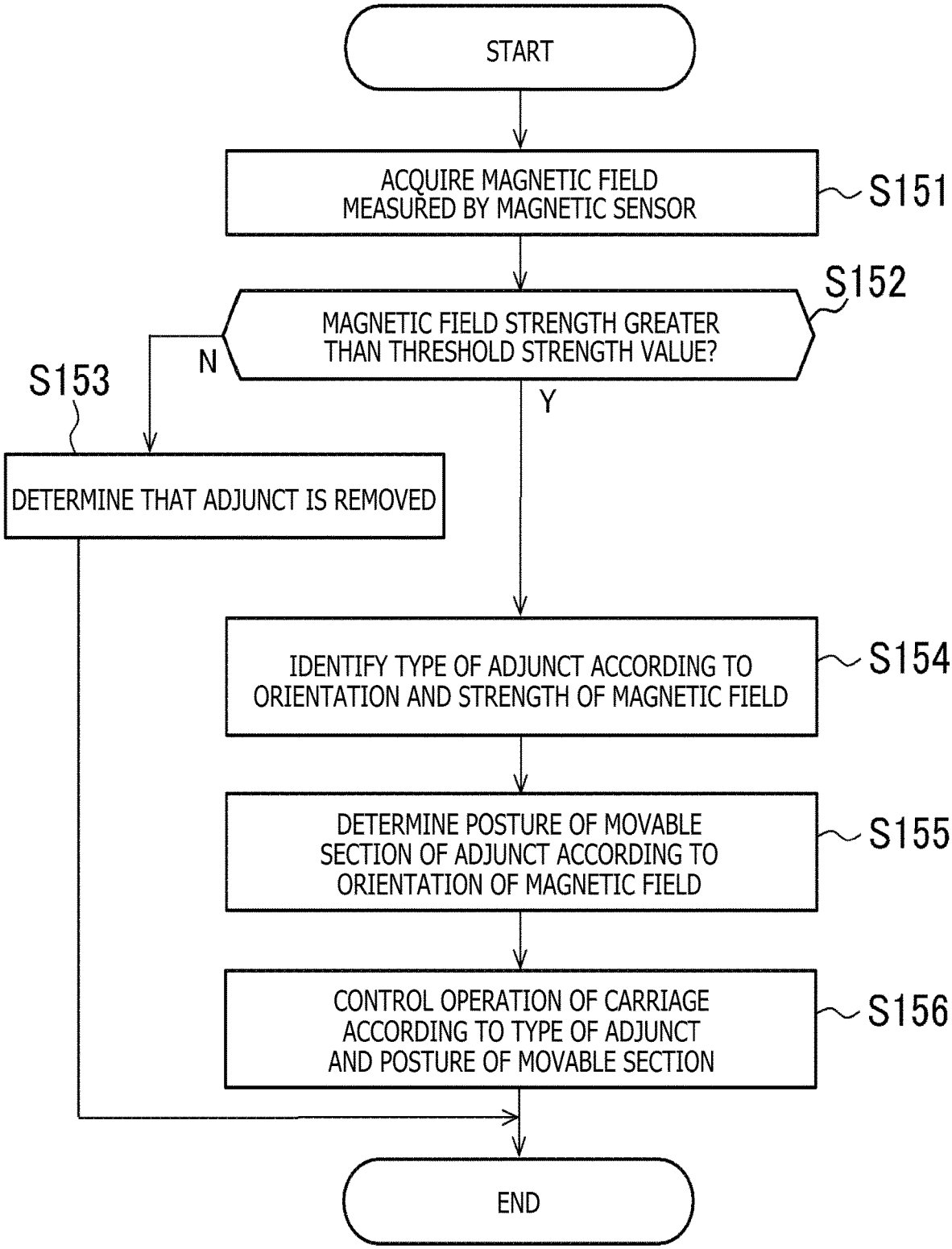

START
ACQUIRE MAGNETIC FIELD MEASURED BY MAGNETIC SENSOR
S151
MAGNETIC FIELD STRENGTH GREATER THAN THRESHOLD STRENGTH VALUE?
S152
N
Y
S153
DETERMINE THAT ADJUNCT IS REMOVED
IDENTIFY TYPE OF ADJUNCT ACCORDING TO ORIENTATION AND STRENGTH OF MAGNETIC FIELD
S154
DETERMINE POSTURE OF MOVABLE SECTION OF ADJUNCT ACCORDING TO ORIENTATION OF MAGNETIC FIELD
S155
CONTROL OPERATION OF CARRIAGE ACCORDING TO TYPE OF ADJUNCT AND POSTURE OF MOVABLE SECTION
S156
END

FIG. 10

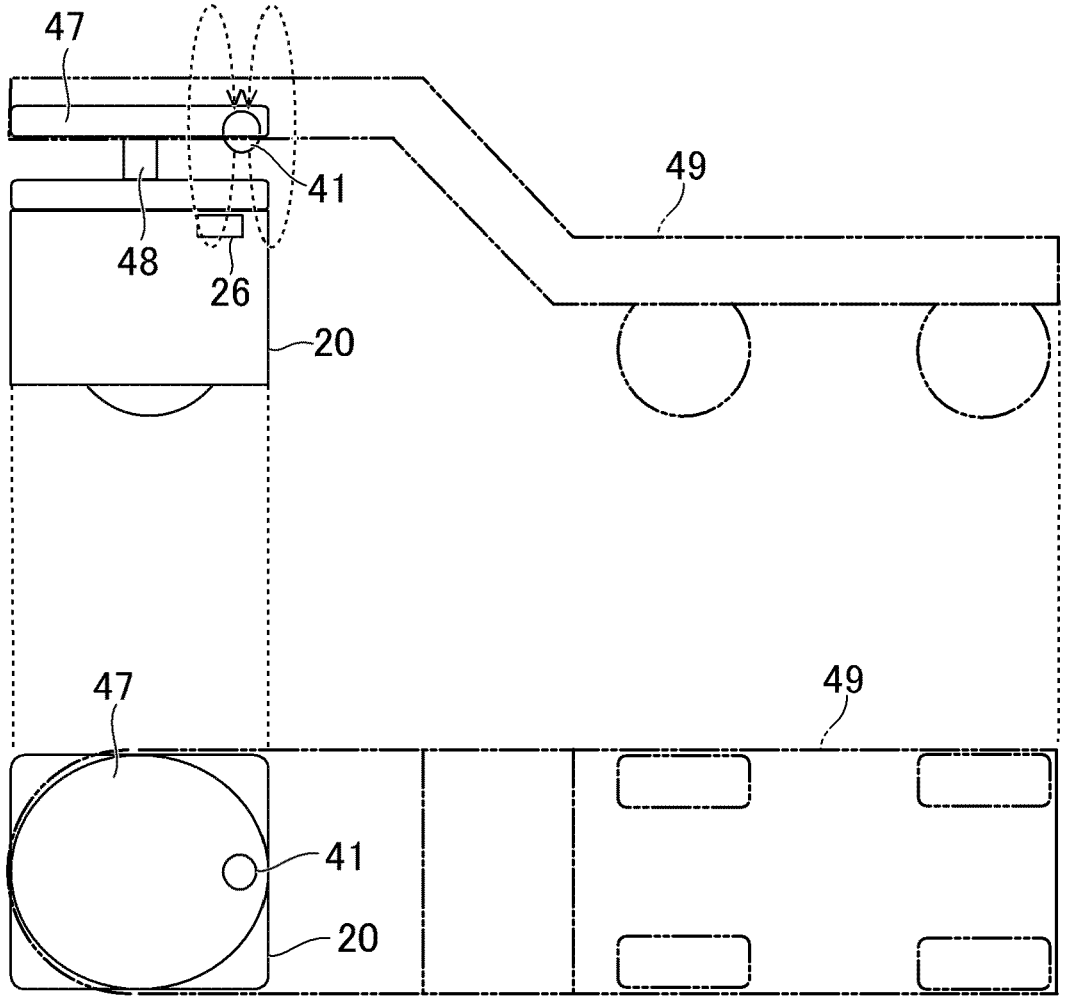


FIG. 11

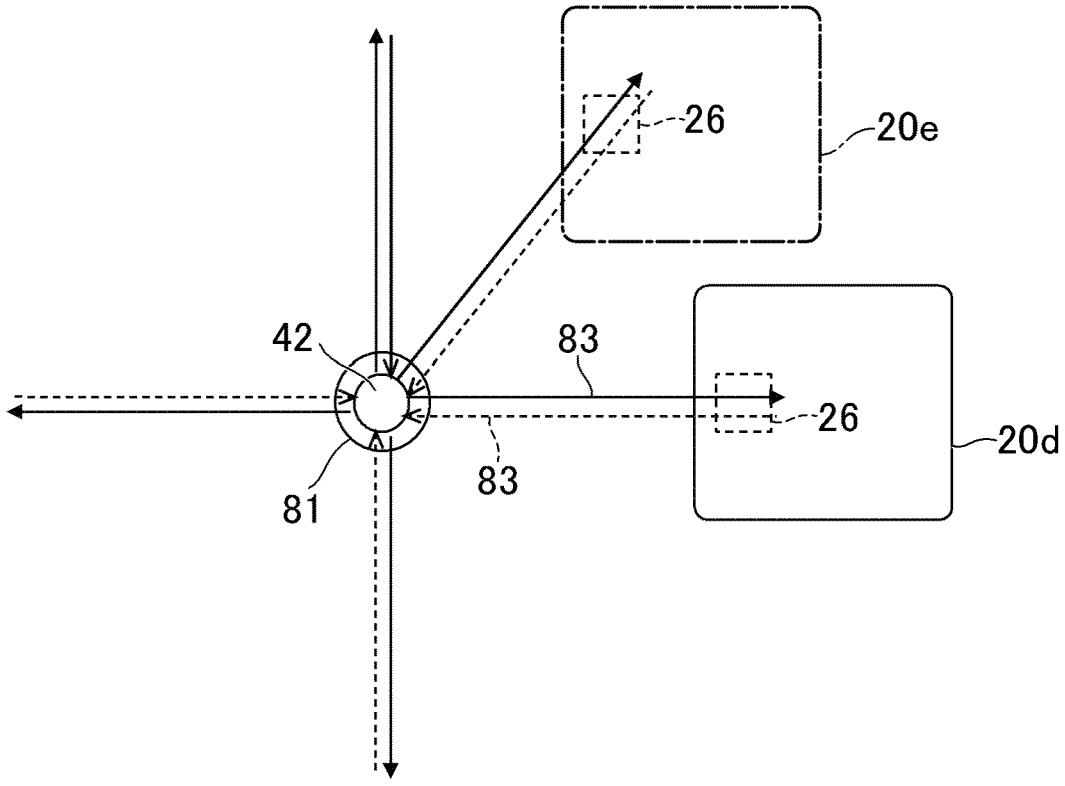


FIG. 12

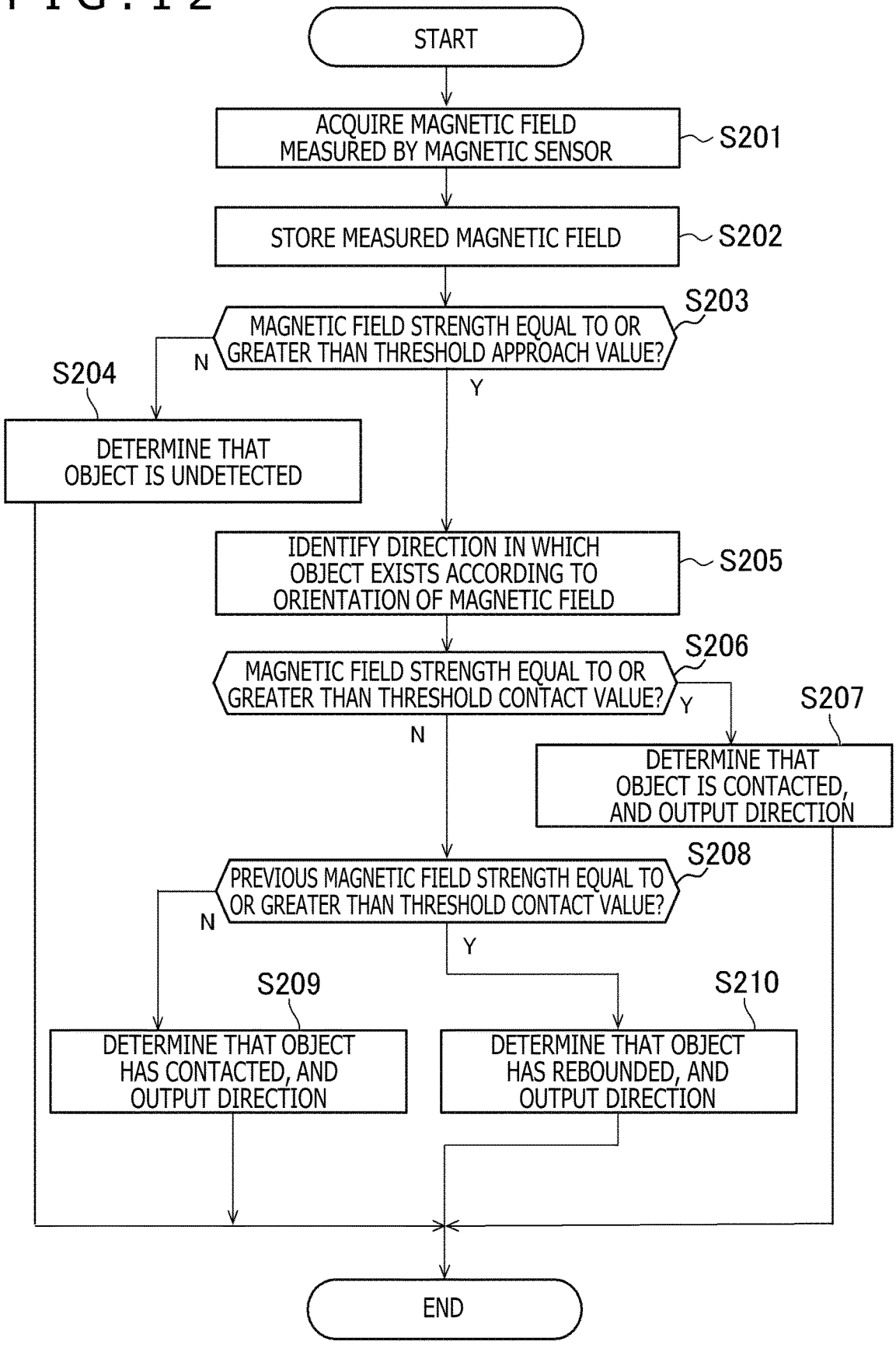

START
ACQUIRE MAGNETIC FIELD MEASURED BY MAGNETIC SENSOR
S201
STORE MEASURED MAGNETIC FIELD
S202
MAGNETIC FIELD STRENGTH EQUAL TO OR GREATER THAN THRESHOLD APPROACH VALUE?
S203
N
Y
S204
DETERMINE THAT OBJECT IS UNDETECTED
IDENTIFY DIRECTION IN WHICH OBJECT EXISTS ACCORDING TO ORIENTATION OF MAGNETIC FIELD
S205
MAGNETIC FIELD STRENGTH EQUAL TO OR GREATER THAN THRESHOLD CONTACT VALUE?
S206
Y
N
S207
DETERMINE THAT OBJECT IS CONTACTED, AND OUTPUT DIRECTION
PREVIOUS MAGNETIC FIELD STRENGTH EQUAL TO OR GREATER THAN THRESHOLD CONTACT VALUE?
S208
N
Y
S209
S210
DETERMINE THAT OBJECT HAS CONTACTED, AND OUTPUT DIRECTION
DETERMINE THAT OBJECT HAS REBOUNDED, AND OUTPUT DIRECTION
END

FIG. 13

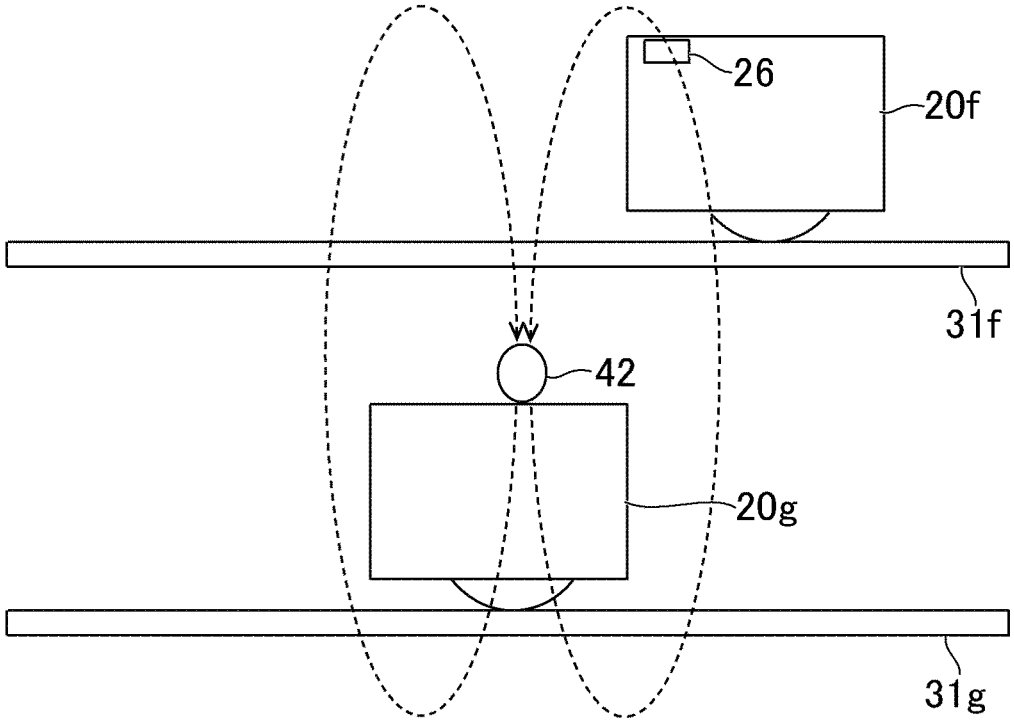
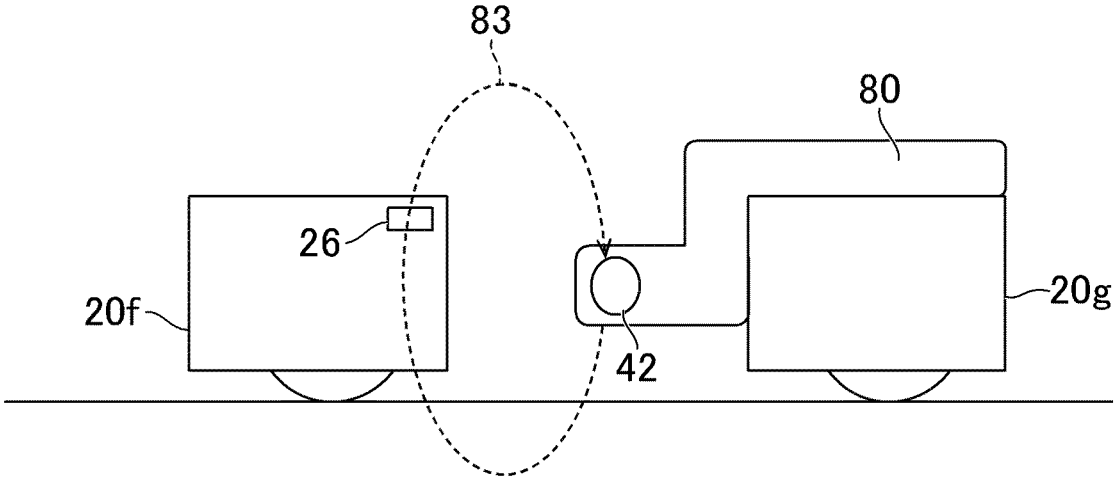


FIG. 14



TOY SYSTEM, CASING, SEPARATE TOY, SEPARATE TOY ASSESSMENT METHOD, AND PROGRAM

TECHNICAL FIELD

[0001] The present invention relates to a toy system, a casing, a separate toy, a separate toy assessment method, and a program.

BACKGROUND ART

[0002] A wide variety of toy systems using separate toys together with a toy main body are proposed. It is conceivable that the separate toys may be figures such as animals, humans, and robots, and vehicles such as automobiles. The toy main body needs to determine a status, for example, by checking which separate toy is being currently played with by a player. It is conceivable that such determination may be made by using, for example, a mechanical structure, communication, or an optical sensor.

[0003] Disclosed in PTL 1 is a technology for mounting a separate toy on a carriage and identifying a type of the separate toy by using a near field communication (NFC) tag.

CITATION LIST

Patent Literature

PTL 1

[0004] PCT Patent Publication No. WO2018/025467

SUMMARY

Technical Problems

[0005] In a case where a mechanical structure is used to identify a type of a separate toy, it is difficult to improve durability. In a case where communication or an optical sensor is used to identify a type of a separate toy, it is difficult to reduce cost.

[0006] The present invention has been made in view of the above circumstances. An objective of the present invention is to provide a lower cost, highly durable technology for determining a status of a separate toy.

Solution to Problems

[0007] In order to solve the above problems, a toy system according to the present invention includes a magnetic sensor and a determination section. The magnetic sensor detects an orientation and a magnitude of a magnetic field. Based on an output from the magnetic sensor, the determination section determines that one of a plurality of separate toys having magnetic field generation means has approached the magnetic sensor and determines which of the separate toys has approached the magnetic sensor. The magnetic field generation means are mounted individually on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture.

[0008] A casing according to the present invention includes a to-be-engaged section and a magnetic sensor. An engagement section disposed on each of a plurality of separate toys having magnetic field generation means engages with the to-be-engaged section. The magnetic field generation means are mounted individually on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture. The magnetic sensor detects an orientation and a magnitude of a magnetic field generated by the magnetic field generation means mounted on one of the separate toys.

[0009] A separate toy according to the present invention includes an engagement section and magnetic field generation means. The engagement section engages with a to-be-engaged section disposed on a casing. The magnetic field generation means is mounted in such a manner as to generate a magnetic field oriented differently from every other separate toy in a standard posture and allow a magnetic sensor included in the casing to detect an orientation and a magnitude of the generated magnetic field.

[0010] A separate toy assessment method according to the present invention includes the steps of acquiring an orientation and a magnitude of a magnetic field detected by a magnetic sensor, and, based on the acquired orientation and magnitude of the magnetic field, determining that one of a plurality of separate toys having magnetic field generation means has approached the magnetic sensor and determining which of the separate toys has approached the magnetic sensor. The magnetic field generation means are mounted on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture.

[0011] A program according to the present invention causes a computer to function as means for acquiring an orientation and a magnitude of a magnetic field detected by a magnetic sensor, and, based on the acquired orientation and magnitude of the magnetic field, means for determining that one of a plurality of separate toys having magnetic field generation means has approached the magnetic sensor and determining which of the separate toys has approached the magnetic sensor. The magnetic field generation means are mounted on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture.

[0012] The present invention makes it possible to determine a status of a separate toy while reducing cost and providing high durability.

[0013] An embodiment of the present invention may be configured so as to further include the plurality of separate toys.

[0014] An embodiment of the present invention may be configured so that the magnetic sensor is built in a casing and that the casing includes a to-be-engaged section with which an engagement section disposed on each of the separate toys engages.

[0015] An embodiment of the present invention may be configured so that, in a case where a magnetic field having a magnitude equal to or greater than a threshold value and oriented in a predetermined direction is continuously detected for a predetermined period of time, the determination section determines that one of the separate toys has approached the magnetic sensor and determines which of the separate toys has approached the magnetic sensor.

[0016] An embodiment of the present invention may be configured so as to further include movement detection means for detecting whether or not the magnetic sensor is moving, in which, in a case where the magnetic sensor is moving, the determination section determines that one of the separate toys has approached the magnetic sensor and determines which of the separate toys has approached the magnetic sensor.

[0017] An embodiment of the present invention may be configured so that the separate toys each include a movable section for changing an orientation relative to the engagement section, and that the magnetic field generation means is disposed on the movable section, and further that the determination section determines the orientation of the movable section based on an output from the magnetic sensor.

[0018] In order to solve the above-mentioned problems, another toy system according to the present invention includes a casing, a magnetic sensor, and a determination section. The magnetic sensor is disposed on the casing to detect an orientation and a magnitude of a magnetic field. The determination section determines, based on an output from the magnetic sensor, that a separate toy separated from the casing in which magnetic field generation means for generating a magnetic field is mounted has come into contact with or approached the casing.

[0019] The present invention is also able to achieve low cost and provide high durability in a toy system capable of determining a status of a separate toy.

[0020] An embodiment of the present invention may be configured so that, in a case where the magnetic sensor detects a magnetic field having a magnitude equal to or greater than a predetermined first threshold value, the determination section determines that the separate toy has come into contact with the casing, and that, in a case where the magnetic sensor detects a magnetic field having a magnitude equal to or greater than a second threshold value which is smaller than the first threshold value, the determination section determines that the separate toy has approached the casing. The second threshold value may be greater than a value of a magnitude of geomagnetism detected by the magnetic sensor.

[0021] An embodiment of the present invention may be configured so that the determination section determines, based on the orientation of a magnetic field detected by the magnetic sensor, a direction of the separate toy when the separate comes into contact with or approaches the casing.

[0022] An embodiment of the present invention may be configured so that the determination section determines, based on changes in the magnitude of a magnetic field detected by the magnetic sensor, that the separate toy has rebounded after hitting the casing.

BRIEF DESCRIPTION OF DRAWINGS

[0023] FIG. **1** is a diagram illustrating an example of a toy system according to a first embodiment of the present invention.

[0024] FIG. **2** is a diagram illustrating a hardware configuration of the toy system.

[0025] FIG. **3** is a bottom view illustrating a carriage.

[0026] FIG. **4** is a perspective view illustrating an example of an adjunct and the carriage.

[0027] FIG. **5**A is a diagram illustrating an example of a relation between a magnetic sensor and a magnetic field of a magnet.

[0028] FIG. **5**B is a diagram illustrating another example of the relation between the magnetic sensor and the magnetic field of the magnet.

[0029] FIG. **6** is a block diagram illustrating functions implemented by the toy system.

[0030] FIG. **7** is a flowchart illustrating an example of processing performed by a magnetic determination section, a movement detection section, and a carriage control section.

[0031] FIG. **8** is a diagram illustrating an example of a relation between a magnetic sensor and a magnet of an adjunct according to a second embodiment.

[0032] FIG. **9** is a flowchart illustrating an example of processing performed by the magnetic determination section and the carriage control section.

[0033] FIG. **10** is a diagram illustrating another example of the adjunct and the carriage.

[0034] FIG. **11** is a diagram illustrating an example of a relation between an external object and the carriage according to a third embodiment.

[0035] FIG. **12** is a flowchart illustrating an example of processing performed by the magnetic determination section.

[0036] FIG. **13** is a diagram illustrating an example of the carriage and another carriage.

[0037] FIG. **14** is a diagram illustrating another example of the carriage and another carriage.

DESCRIPTION OF EMBODIMENTS

[0038] Embodiments of the present invention will now be described with reference to the accompanying drawings. When elements appearing in this document have the same functions, they are designated by the same reference signs and will not be redundantly described.

First Embodiment

[0039] Described in conjunction with a first embodiment of the present invention is a toy system that includes a self-propelled device and a separate toy mounted on the self-propelled device, and identifies a type of the separate toy.

[0040] FIG. **1** is a diagram illustrating an example of the toy system according to an embodiment of the present invention. FIG. **2** is a diagram illustrating an example of a hardware configuration of the toy system according to an embodiment of the present invention. The toy system according to the present invention includes a device control apparatus **10**, carriages **20***a* and **20***b*, a controller **17**, and a cartridge **18**. The carriages **20***a* and **20***b*, which are mobile devices having a camera **24** and a magnetic sensor **26**, have the same functions. The carriages **20***a* and **20***b* are hereinafter referred to as the carriages **20** unless they need to be distinguished particularly from each other. The device control apparatus **10** wirelessly controls the carriages **20**. The controller **17** is an input apparatus acquiring an operation performed by a user and is connected to the device control apparatus **10** via a cable. FIG. **3** is a bottom view illustrating an example of one of the carriages **20**. The carriages **20** each further include a power switch **250**, a switch **222**, and two wheels **254**.

[0041] The device control apparatus **10** includes a processor **11**, a storage section **12**, a communication section **13**, and an input/output section **14**. The carriages **20** each include a processor **21**, a storage section **22**, a communication section **23**, a camera **24**, two motors **25**, and a magnetic sensor **26**. The device control apparatus **10** may be a dedicated apparatus for control or a general-purpose computer.

[0042] The processor **11** operates in accordance with a program stored in the storage section **12** and controls, for example, the communication section **13** and the input/output section **14**. The processor **21** operates in accordance with a program stored in the storage section **22** and controls, for example, the communication section **23**, the camera **24**, and the motors **25**. The above-mentioned programs are supplied on a flash memory or other computer-readable storage medium in the cartridge **18**. However, the programs may alternatively be supplied through a network such as the Internet.

[0043] The storage section **12** includes a dynamic random access memory (DRAM) and a flash memory, which are built in the device control apparatus **10**, and includes, for example, the flash memory in the cartridge **18**. The storage section **22** includes, for example, a DRAM and a flash memory. The storage sections **12** and **22** store the above-mentioned programs. Further the storage sections **12** and **22** store information and computation results inputted, for example, from the processors **11** and **21** and the communication sections **13** and **23**.

[0044] The communication sections **13** and **23** each include, for example, an integrated circuit and an antenna in order to communicate with other equipment. The communication sections **13** and **23** are capable of communicating with each other in accordance, for example, with a Bluetooth (registered trademark) protocol. Under the control of the processors **11** and **21**, the communication sections **13** and **23** input information received from other apparatuses to the storage sections **12** and **22**, and transmit information to the other apparatuses. It should be noted that the communication section **13** may be capable of communicating with the other apparatuses through a local area network (LAN) or other network.

[0045] The input/output section **14** includes a circuit for acquiring information from an input device such as the controller **17**, and a circuit for controlling an output device such as a sound output device and an image display device. The input/output section **14** acquires an input signal from the input device and inputs information obtained by converting the acquired input signal to the processor **11** and the storage section **12**. Further, under the control, for example, of the processor **11**, the input/output section **14** outputs a sound to a speaker and outputs an image to a display device.

[0046] The motors **25** are what is generally called servomotors whose rotation direction, rotation amount, and rotation speed are controlled by the processor **21**. One wheel **254** is assigned to each of the two motors **25**. The motors **25** respectively drive the assigned wheels **254**.

[0047] The camera **24** is disposed so as to capture an image of an area below a carriage **20**. The camera **24** captures an image of a pattern printed, for example, on a sheet on which the carriage **20** is placed. In the present embodiment, a pattern recognizable by in the infrared frequency domain is printed, for example, on the sheet so that the camera **24** captures an image of such infrared light. Unit patterns of a predetermined size (e.g., 0.2 mm square) are arrayed in a matrix form, for example, on the sheet. Each of the unit patterns is an image obtained by encoding the coordinates of the position where the unit pattern is disposed. The carriage **20** and the device control apparatus **10** acquire the position and orientation of the carriage **20** by decoding the patterns included in the image captured by the camera **24**.

[0048] The magnetic sensor **26** detects a magnetic field generated, for example, by a magnet. The magnetic sensor **26**, which is what is generally called a three-axis magnetic sensor, acquires the magnetic field in the form of a three-dimensional vector. The magnetic sensor **26** may alternatively be a two-axis magnetic sensor.

[0049] FIG. **4** is a perspective view illustrating an example of an adjunct **40** and the carriage **20**. The adjunct **40** is a separate toy separated from the carriage **20**. Although FIG. **4** depicts only one adjunct **40**, other types of the adjunct **40** also exist in reality. A plurality of adjuncts **40** may be included in the toy system. The adjunct **40** includes a pedestal **45**, a hinge **43** connected to the pedestal **45**, and a movable section **44** movable via the hinge **43**. A shape of the adjunct **40** is not limited to the one depicted in FIG. **4**. For example, some of the included adjuncts **40** may exclude the hinge **43** and the movable section **44**. Protrusions **29** are formed on a top surface of the carriage **20**. Engagement sections engaging with the protrusions **29** are formed on an underside of the pedestal **45**. The engagement sections are, for example, recessed shape to match the protrusions **29**. The magnetic sensor **26** is built in the casing of the carriage **20**. In the example of FIG. **4**, the magnetic sensor **26** is disposed on a back side of the top surface of the carriage **20**.

[0050] Further, a magnet **41** for generating a magnetic field is embedded in the adjunct **40**. The position and strength of the magnet **41** are determined so as to enable the magnetic sensor **26** to detect a magnetic field generated by the magnet **41**.

[0051] The orientation of magnetic poles of the magnet **41** varies with the adjunct **40**. FIG. **5**A is a diagram illustrating an example of a relation between the magnetic sensor **26** and the magnetic field of the magnet **41**. FIG. **5**B is a diagram illustrating another example of the relation between the magnetic sensor **26** and the magnetic field of the magnet **41**. The illustrations in FIGS. **5**A and **5**B assume that the x-axis is parallel to the direction of connecting the two wheels **254** of the carriage **20**, and that the z-axis is extended in the up-down direction, and further that the y-axis is perpendicular to the x- and z-axes. FIGS. **5**A and **5**B depict only magnetic field lines **83** passing through the magnetic sensor **26**. In the example of FIG. **5**A, the two magnetic poles of the magnet **41** are lined up along the x-axis so that the magnetic sensor **26** detects a magnetic field whose x-axis negative direction component is greater than other components. Meanwhile, in the example of FIG. **5**B, the two magnetic poles of the magnet **41** are lined up along the z-axis so that the magnetic sensor **26** detects a magnetic field whose z-axis negative direction component is greater than other components.

[0052] When the plurality of adjuncts **40** are of different types, the magnet **41** is attached to each of the adjuncts **40** in such a manner as to generate differently oriented magnetic fields. In a case where the adjuncts **40** engage with the carriages **20** in a predetermined posture, the magnetic field detected by the magnetic sensor **26** varies from one adjunct **40** to another. Even if the two magnetic poles are lined up along one of the x, y, and z-axes, the orientation of N and S poles can be reversed for each axis. Therefore, six different types of adjuncts **40** can be identified simply by determining the strongest component and orientation of the magnetic field. Further, a wider variety of adjuncts **40** can be identified by fine-tuning the range of orientation of the magnetic field reaching the magnetic sensor **26**.

[0053] It should be noted that the magnet **41** may be a magnet sheet. In such a case, the properties and mounting position of the magnet sheet are designed in such a manner that the magnetic field outputted from the magnet sheet attached to the adjuncts **40** complies with the adjuncts **40**.

[0054] Processing performed for type identification will now be described in more detail. FIG. **6** is a block diagram illustrating the functions implemented by the toy system. The toy system functionally includes a magnetic determination section **51**, a carriage control section **52**, and a movement detection section **53**. The magnetic determination section **51**, the carriage control section **52**, and the movement detection section **53** are mainly implemented by allowing the processor **11** included in the device control apparatus **10** to execute a program stored in the storage section **12** for purposes of controlling the carriage **20** via the communication section **13**. Further, some or all of the functions may be implemented by allowing the processor **21** included in the carriage **20** to execute a program stored in the storage section **22** for purposes of controlling the camera **24** and the magnetic sensor **26**. Further, some or all of the functions may be executed by allowing the device control apparatus **10** and the carriage **20** to perform cooperative processing so as to exchange data through the communication sections **13** and **23**.

[0055] Based on the orientation and magnitude of a magnetic field detected by the magnetic sensor **26**, the magnetic determination section **51** determines that one of the plurality of adjuncts **40** has approached the magnetic sensor **26** and determines which of the adjuncts **40** has approached the magnetic sensor **26**.

[0056] Based on operation of the motors **25** or acceleration acquired by an undepicted acceleration sensor, the movement detection section **53** detects whether or not the carriage **20** having the magnetic sensor **26** is moving.

[0057] Based on the result of determination by the magnetic determination section **51**, the carriage control section **52** controls operation of the carriage **20**.

[0058] FIG. **7** is a flowchart illustrating an example of processing performed by the magnetic determination section **51**, the movement detection section **53**, and the carriage control section **52**. The processing depicted in FIG. **7** is performed after the mounting of an adjunct **40** is started by the user and before the processing, for example, of a game is performed by the carriage control section **52** through the use of the adjunct **40**. The following description deals with a case where processing in the magnetic determination section **51** is performed by the device control apparatus **10**. However, the processing may alternatively be performed by the carriage **20**. It should be noted that a later-described continuation count is assumed to be initialized to zero before the processing.

[0059] First, the magnetic determination section **51** acquires a magnetic field measured by the magnetic sensor **26** (step S**101**). More specifically, the processor **11** in the device control apparatus **10** controls the carriage **20** via the communication section **13** and acquires information indicative of the orientation and strength of the magnetic field outputted from the magnetic sensor **26**.

[0060] If the strength of the acquired magnetic field is smaller than a threshold strength value ("N" in step S**102**), the magnetic determination section **51** determines that the adjunct **40** has not approached the carriage **20**, initializes the continuation count to zero (step S**103**), and repeats step S**101** and subsequent steps.

[0061] If the strength of the acquired magnetic field is equal to or greater than the threshold strength value ("Y" in step S**102**), the magnetic determination section **51** determines that the adjunct **40** has approached the carriage **20** and increments the continuation count (step S**104**). If the continuation count is less than a threshold time value ("N" in step S**105**), it is possible that the adjunct **40** is being mounted. In this instance, the magnetic determination section **51** repeats step S**101** and subsequent steps, and withholds its determination until the time indicated by the threshold time value elapses.

[0062] If the continuation count is equal to or more than the threshold time value ("Y" in step S**105**), in order to further confirm whether the adjunct **40** is mounted, the magnetic determination section **51** causes the movement detection section **53** to determine whether or not the carriage **20** is moving (step S**106**). In order to determine whether or not the carriage **20** is moving, the movement detection section **53** may check whether or not the motors **25** are running, check whether or not the carriage **20** is being operated by the user, or check an output from the acceleration sensor attached to the carriage **20**. If it is determined that the carriage **20** is not moving ("N" in step S**106**), the magnetic determination section **51** drives the motors **25** to move the carriage **20** for test-run purposes (step S**107**). Subsequently, the magnetic determination section **51** repeats step S**101** and subsequent steps.

[0063] Meanwhile, if it is determined that the carriage **20** is moving (step S**106**), the difference between the magnetic field measured last by the magnetic sensor **26** and the currently measured magnetic field is obtained to determine the amount of change in the magnetic field, and then a check is performed to determine whether or not the amount of change is within a predetermined acceptable range (step S**108**). If the amount of change in the magnetic field is outside the acceptable range ("N" in step S**108**), the magnetic determination section **51** determines that the adjunct **40** is wobbly and outputs an error message indicating that the adjunct **40** is not properly mounted (step S**109**). In this instance, the amount of change in the magnetic field may simply be the amount of change in the strength of the magnetic field or may be a vector representing the amount of magnetic field change in each component. The acceptable range may represent a state where the amount of change in the strength of the magnetic field and the magnitude of the vector are equal to or smaller than predetermined threshold values or a state where the magnitudes of all components of the vector are equal to or smaller than predetermined threshold values. Combining the operations of the magnetic sensor **26** and the carriage **20** not only makes it possible to confirm whether or not the adjunct **40** is properly mounted, but also makes it possible to identify the type of a properly mounted adjunct **40**.

[0064] If the amount of change in the magnetic field is within the acceptable range ("Y" in step S**108**), based on the orientation of the magnetic field, the magnetic determination section **51** identifies the type of the mounted adjunct **40** from among a plurality of different types of adjuncts **40** (step S**110**). As a plurality of different types of adjuncts **40** exist under normal conditions, processing performed in step S**110**

causes the magnetic determination section **51** to determine which of the plurality of adjuncts **40** is mounted.

[0065] Subsequently, the carriage control section **52** changes the operation settings of the carriage **20** according to the identified type of adjunct **40** (step S**111**). For example, the carriage control section **52** changes the operation settings as needed to specify whether the carriage **20** is to be operated by the user and whether the carriage **20** is to be operated by a game program, and then controls the movement of the carriage **20** according to the changed operation settings.

[0066] In the above example, in a case where the carriage **20** is moving, based on the magnetic field detected by the magnetic sensor **26**, the magnetic determination section **51** determines whether the adjunct **40** is mounted on the carriage **20** (a state where the adjunct **40** has approached the carriage **20**) and identifies the type of the mounted adjunct **40**. Meanwhile, in a case where the carriage **20** is moving and a magnetic field having a strength greater than the threshold strength value is newly detected, the magnetic determination section **51** may determine that the carriage **20** is approached by the magnet **41** attached to a toy such as an obstacle, instead of the adjunct **40** mounted on the carriage **20**.

[0067] As described thus far, using the magnetic field generated by the magnet **41** makes it possible to identify the type of adjunct **40** without using an integrated circuit (IC) tag or other complicated and costly device. Further, as a simple structure is employed, it is possible to provide high durability.

Second Embodiment

[0068] A second embodiment of the present invention will now be described. The second embodiment differs from the first embodiment in that a posture of the movable section **44** of the adjunct **40** can be detected. The following description mainly deals with the difference from the first embodiment.

[0069] FIG. **8** is a diagram illustrating an example of a relation between the magnetic sensor **26** and the magnet **41** of the adjunct **40** according to the second embodiment. In the example of FIG. **8**, an angle formed between the movable section **44** and a non-movable section **46** can be changed by using the hinge **43**. Further, the magnet **41** is attached to the movable section **44**. In the example of FIG. **8**, it is assumed that the two magnetic poles of the magnet **41** are lined up in the y-axis direction and that the N pole is positioned forward in FIG. **8**. FIG. **8** depicts only the magnetic field lines **83** passing through the magnetic sensor **26**. The magnetic sensor **26** is positioned further forward of the N pole. It is assumed that the magnetic field lines **83** exiting the N pole pass through the magnetic sensor **26**, reach the underside of the magnetic sensor **26**, and then return to the S pole.

[0070] As is obvious from the description of the magnetic field lines **83** in FIG. **8**, the xz plane component of the orientation of the magnetic field detected by the magnetic sensor **26** changes by an angle β because of an angle α by which the movable section **44** is changed from an upright state (see the broken lines). Taken from a different viewpoint, the orientation of the movable section **44** can be detected from the orientation of the magnetic field. Further, reversing the magnetic poles of the magnet **41** depicted, for example, in FIG. **8** makes it possible to identify at least two types of adjuncts **40**. Further, either of the following two methods makes it possible to identify a wider variety of adjuncts **40**. A first method is to limit a mobility range of the movable section **44** in such a manner that the orientations of magnetic fields detected by the magnetic sensor **26** do not overlap with each other when different types of adjuncts **40** are to be identified. A second method is to vary the magnitude of magnetic force generated by the magnet **41** from one type of adjunct **40** to another so that the strengths of magnetic fields detected by the magnetic sensor **26** do not overlap with each other.

[0071] FIG. **9** is a flowchart illustrating an example of processing performed by the magnetic determination section **51** section and the carriage control section **52**. The processing depicted in FIG. **9** may be performed after the adjunct **40** is mounted by the user and while the carriage control section **52** is performing a game or other processing by using the adjunct **40**. As is the case with the example of FIG. **7**, the processing may be performed by the device control apparatus **10** or by the carriage **20**.

[0072] First, the magnetic determination section **51** acquires a magnetic field measured by the magnetic sensor **26** (step S**151**). More specifically, the processor **11** in the device control apparatus **10** controls the carriage **20** via the communication section **13** and acquires information indicative of the orientation and strength of the magnetic field outputted from the magnetic sensor **26**.

[0073] If the strength of the acquired magnetic field is smaller than a threshold strength value ("N" in step S**152**), the magnetic determination section **51** determines that the adjunct **40** is removed from the carriage **20** and outputs information indicative of the removal to the carriage control section **52** (step S**153**). Although not depicted, in a case where it is determined that the adjunct **40** is removed from the carriage **20**, the carriage control section **52** concludes, for example, that a game is lost, and outputs a message appropriate for such a situation in order to control the movement of the carriage **20**.

[0074] If the strength of the acquired magnetic field is equal to or greater than the threshold strength value ("Y" in step S**152**), based on at least either the orientation or strength of the magnetic field, the magnetic determination section **51** identifies the type of the mounted adjunct **40** from among a plurality of different types of adjuncts **40** (step S**154**). Further, the magnetic determination section **51** determines the posture of the movable section **44** of the adjunct **40** according to the orientation of the magnetic field (step S**155**).

[0075] Next, the carriage control section **52** controls the operation of the carriage **20** according to the identified type of adjunct **40** and the posture of the movable section (step S**156**). For example, in a case where an angle of the movable section **44** is changed to exceed a predetermined angle, the carriage control section **52** may conclude that a game is lost because a doll is knocked down by another carriage **20** and operate the carriage **20** according to a state where the game is lost.

[0076] Here, the movable section **44** need not always be movable via the hinge **43**. FIG. **10** is a diagram illustrating another example of the adjunct **40** and the carriage **20**. In the example of FIG. **10**, the adjunct **40** engaging with the carriage **20** includes a knob **47**. The knob **47** rotates around a shaft **48** and is equivalent to the movable section **44**. The shaft **48** is extended in a vertical direction with respect to the top surface of the carriage **20** which is positioned above the

magnetic sensor **26**. The magnet **41** is positioned so as not to overlap with the rotation axis of the knob **47**. In the example of FIG. **10**, the magnetic poles of the magnet **41** are lined up in the up-down direction. In the example of FIG. **10**, the magnetic determination section **51** identifies the type of adjunct **40** according to at least either the orientation or strength of the magnetic field and determines an angle of the knob **47** according to the orientation of the magnetic field. Further, a trailer **49** rotatable by the shaft **48** may be coupled instead of the knob **47**.

[0077] As described above, using the magnetic sensor **26** makes it possible to identify not only the type of adjunct **40** but also the posture of the movable section **44** including the knob **47**. Further, changing the operation of the carriage **20** according to the identified posture makes it possible to provide a wider variety of operations. For example, it is possible to prevent the trailer **49** from abnormally operating or colliding with an obstacle.

Third Embodiment

[0078] A third embodiment of the present invention will now be described. The third embodiment differs from the first and second embodiments in that the toy system is able to detect the approach and collision of an object not mounted on the carriage **20** and the direction in which the object exists. The following description mainly deals with the difference from the first and second embodiments.

[0079] FIG. **11** is a diagram illustrating an example of a relation between an external object and the carriage **20** according to the third embodiment. FIG. **11** is a plan view. In the example of FIG. **11**, a carriage **20***d* and an object **81** are disposed apart from each other. A magnet **42** is attached to the object **81**. The two magnetic poles of the magnet **42** are lined up in the up-down direction. The N pole is on the upper side, and the S pole is on the lower side. The magnetic field lines **83** indicated by the solid lines in FIG. **11** exit the N pole, pass above a sheet on which the carriage **20***d* is disposed, and reach the magnetic sensor **26**. The magnetic field lines **83** indicated by broken lines leave the magnetic sensor **26**, pass below the sheet, and return to the S pole.

[0080] In the example of FIG. **11**, the strength of the magnetic field increases with a decrease in the distance to the magnet **42** of the object **81**. Further, in FIG. **11**, the direction of the magnet **42** as viewed from a carriage **20***e* is different from the direction of the magnet **42** as viewed from the carriage **20***d*. However, as regards both the carriage **20***d* and the carriage **20***e*, the orientation of components along the plane of the magnetic field lines **83** reaching the magnetic sensor **26** is opposite to the direction in which the magnet **42** exists. It should be noted that, in a case where the magnetic poles of the magnet **42** are reversed, the orientation of components along the plane of the magnetic field lines **26** is the direction in which the magnet **42** exists. This signifies that the orientation of the magnetic field detected by the polarity magnetic sensor **26** of the magnet **42** indicates the direction in which the object **81** exists. The above-described configuration enables the toy system to determine the approach to, and collision with, the object **81** based on the strength of the magnetic field detected by the magnetic sensor **26**, and determine the direction of the object **81** based on the orientation of the magnetic field.

[0081] FIG. **12** is a flowchart illustrating an example of processing performed by the magnetic determination section **51**. As is the case with the example of FIG. **7**, the processing may be performed by the device control apparatus **10** or by the carriage **20**. The processing depicted in FIG. **12** is repeatedly performed when the carriage **20** is operating.

[0082] First, the magnetic determination section **51** acquires a magnetic field measured by the magnetic sensor **26** (step S**201**). More specifically, the processor **11** in the device control apparatus **10** controls the carriage **20** via the communication section **13** and acquires information indicative of the orientation and strength of the magnetic field outputted from the magnetic sensor **26**. Further, in order to make temporal changes in the magnetic field verifiable, the magnetic determination section **51** causes the storage section **12** to store the measured magnetic field (step S**202**).

[0083] If the strength of the acquired magnetic field is smaller than a threshold approach value ("N" in step S**203**), the magnetic determination section **51** determines that the object **81** is undetected and outputs information indicative of the undetection to the carriage control section **52** (step S**204**). The threshold approach value is a threshold value for determining whether or not the carriage **20** has approached the object **81** and is greater than a value indicative of a strength of geomagnetism detected by the magnetic sensor **26**. For example, when the distance between the magnet **42** and the magnetic sensor **26** of the carriage **20** is approximately 5 cm, a magnetic field having a magnitude greater than the threshold approach value is detected.

[0084] If the strength of the acquired magnetic field is equal to or greater than the threshold approach value ("Y" in step S**203**), the magnetic determination section **51** identifies, based on the orientation of the magnetic field, the direction in which the object **81** exists (step S**205**). More specifically, based on the planar components (xy components) of the measured magnetic field, the magnetic determination section **51** identifies the direction in which the object **81** exists. Next, the magnetic determination section **51** determines whether or not the strength of the magnetic field is equal to or greater than a threshold contact value (step S**206**). The threshold contact value is a threshold value for determining whether or not the carriage **20** is contacted and is greater than the threshold approach value.

[0085] If the strength of the magnetic field is equal to or greater than the threshold contact value ("Y" in step S**206**), the magnetic determination section **51** determines that the carriage **20** is in contact with the object **81** and outputs information indicative of the contact and the identified direction of the object **81** to the carriage control section **52** (step S**207**). Meanwhile, if the strength of the magnetic field is smaller than the threshold contact value ("N" in step S**206**), the magnetic determination section **51** determines whether or not the previous strength of the magnetic field is equal to or greater than the threshold contact value (step S**208**). It should be noted that, in a case where the strength of the magnetic field is smaller than the threshold contact value, the carriage **20** has approached the object **81**.

[0086] If the previous strength of the magnetic field is smaller than the threshold contact value ("N" in step S**208**), the magnetic determination section **51** merely determines that the carriage **20** has approached the object **81** and outputs information indicative of the approach and the identified direction of the object **81** to the carriage control section **52** (step S**209**). Meanwhile, if the previous strength of the magnetic field is equal to or greater than the threshold contact value ("Y" in step S**208**), the magnetic determination section **51** determines that the object **81** is approached

by the carriage **20** and then has rebounded after coming into contact with the carriage **20** and outputs information indicative of the rebound and the identified direction of the object **81** to the carriage control section **52** (step S**210**).

[0087] The carriage control section **52** controls the operation of the carriage **20** according to the information obtained from the magnetic determination section **51**. For example, the carriage control section **52** may operate the carriage **20** according to a user-specified direction in a case where the object **81** is undetected, move the carriage **20** toward the object **81** in a case where it is merely determined that the carriage **20** has approached the object **81**, and stop the movement of the carriage **20** in a case where it is determined that the carriage **20** has come into contact with the object **81**. Further, in a case where it is determined that the object **81** has rebounded, the carriage control section **52** may cause the carriage **20** to perform a predetermined operation (e.g., an operation indicative of a troubled state) in order to indicate that the object **81** has rebounded. Performing such an operation makes it possible, for example, to implement a treasure hunting game and a motion performed by an animal (equivalent to the carriage **20**) to find and approach a bait (equivalent to the object **81**).

[0088] Here, a game like tag can be implemented by using the magnet **42** and two carriages **20***f* and **20***g*. In this case, the carriage **20***g* to which the magnet **42** is attached is used instead of the object **81**. FIG. **13** is a diagram illustrating an example of the carriage **20***f* and other carriage **20***g*. In the example of FIG. **13**, a mat **31***f* on which the carriage **20***f* is disposed is different from a mat **31***g* on which the carriage **20***g* is disposed. Further, the mat **31***f* is disposed above the mat **31***g*. The carriage **20***f* is operated by one user, and the carriage **20***g* is operated by another user or by a programmed logic.

[0089] In a case where the magnetic determination section **51** determines that the magnet **42** has approached the carriage **20***f*, for example, the carriage control section **52** determines that the carriage **20***f* is caught, and then causes the carriage **20***f* to perform an operation indicative of the capture. This makes it easy to determine that the carriage **20***f* and the carriage **20***g* have approached each other.

[0090] Further, the magnet **42** may be attached to a tip of an adjunct **80** that is to be mounted on the other carriage **20***g*. FIG. **14** is a diagram illustrating another example of the carriage **20***f* and other carriage **20***g*. In the example of FIG. **14**, the carriage **20***f* and the carriage **20***g* are disposed on the same sheet. In the example of FIG. **14**, the adjunct **80** is equivalent to the object **81**. The above-described configuration enables the magnetic determination section **51** to determine whether the adjunct **80** is contacted. Therefore, when, for example, the carriage control section **52** operates the carriages **20***f* and **20***g* in such a manner as to avoid severe collision, it is possible to prevent the carriages **20***f* and **20***g* from toppling over. Further, the carriages **20** can perform a wider variety of operations when the carriages **20***f* and **20***g* move in a predetermined manner in a case where the approach or the contact is determined.

1. A toy system comprising:

a magnetic sensor that detects an orientation and a magnitude of a magnetic field; and

a determination section that, based on an output from the magnetic sensor, determines that one of a plurality of separate toys having magnetic field generation means has approached the magnetic sensor and determines which of the separate toys has approached the magnetic sensor, the magnetic field generation means being mounted individually on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture.

2. The toy system according to claim **1**, further comprising:

the plurality of separate toys.

3. The toy system according to claim **1**,

wherein the magnetic sensor is built in a casing, and the casing includes a to-be-engaged section with which an engagement section disposed on each of the separate toys engages.

4. The toy system according to claim **1**,

wherein, in a case where a magnetic field having a magnitude equal to or greater than a threshold value and oriented in a predetermined direction is continuously detected for a predetermined period of time, the determination section determines that one of the separate toys has approached the magnetic sensor and determines which of the separate toys has approached the magnetic sensor.

5. The toy system according to claim **4**, further comprising:

movement detection means for detecting whether or not the magnetic sensor is moving,

wherein, in a case where the magnetic sensor is moving, the determination section determines that one of the separate toys has approached the magnetic sensor and determines which of the separate toys has approached the magnetic sensor.

6. The toy system according to claim **3**,

wherein the separate toys each include a movable section for changing an orientation relative to the engagement section,

the magnetic field generation means is disposed on the movable section, and

the determination section determines the orientation of the movable section based on an output from the magnetic sensor.

7. A toy system comprising:

a casing;

a magnetic sensor that is disposed on the casing to detect an orientation and a magnitude of a magnetic field; and

a determination section that determines, based on an output from the magnetic sensor, that a separate toy separated from the casing in which magnetic field generation means for generating a magnetic field is mounted has come into contact with or approached the casing.

8. The toy system according to claim **7**,

wherein, in a case where the magnetic sensor detects a magnetic field having a magnitude equal to or greater than a predetermined first threshold value, the determination section determines that the separate toy has come into contact with the casing, and,

in a case where the magnetic sensor detects a magnetic field having a magnitude equal to or greater than a second threshold value which is smaller than the first threshold value, the determination section determines that the separate toy has approached the casing, the second threshold value being greater than a value of a magnitude of geomagnetism detected by the magnetic sensor.

9. The toy system according to claim **7**,
wherein the determination section determines, based on the orientation of a magnetic field detected by the magnetic sensor, a direction of the separate toy when the separate toy comes into contact with or approaches the casing.

10. The toy system according to claim **7**,
wherein the determination section determines, based on changes in the magnitude of a magnetic field detected by the magnetic sensor, that the separate toy has rebounded after hitting the casing.

11. A casing comprising:
a to-be-engaged section with which an engagement section engages, the engagement section being disposed on each of a plurality of separate toys having magnetic field generation means, the magnetic field generation means being mounted individually on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture; and
a magnetic sensor that detects an orientation and a magnitude of a magnetic field generated by the magnetic field generation means mounted on one of the separate toys.

12. A separate toy comprising:
an engagement section that engages with a to-be-engaged section disposed on a casing; and
magnetic field generation means that is mounted in such a manner as to generate a magnetic field oriented differently from every other separate toy in a standard posture and allow a magnetic sensor included in the casing to detect an orientation and a magnitude of the generated magnetic field.

13. A separate toy assessment method comprising:
acquiring an orientation and a magnitude of a magnetic field detected by a magnetic sensor; and,
based on the acquired orientation and magnitude of the magnetic field, determining that one of a plurality of separate toys having magnetic field generation means has approached the magnetic sensor and determining which of the separate toys has approached the magnetic sensor, the magnetic field generation means being mounted on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture.

14. A program for a computer, comprising:
by a magnetic sensor, acquiring an orientation and a magnitude of a magnetic field detected; and,
by a determination section, based on the acquired orientation and magnitude of the magnetic field, determining that one of a plurality of separate toys having magnetic field generation means has approached the magnetic sensor and determining which of the separate toys has approached the magnetic sensor, the magnetic field generation means being mounted on the separate toys in such a manner as to generate differently oriented magnetic fields in a standard posture.

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